Chapter 4
Thermal Spray Coating Cost and Service Life

4-1. Introduction

This chapter contrasts paint and thermal spray coatings based on cost and expected service life. Both paint and thermal spray coatings may be used to provide corrosion protection for most civil works applications. The use of thermal spray coatings is preferred on the basis of fitness-for-purpose for a few specific applications, including corrosion protection in very turbulent ice- and debris-laden water, high-temperature applications, and zebra mussel resistance. Thermal spray coatings may also be selected because of restrictive air pollution regulations that do not allow the use of some paint coatings specified in CEGS-09965. For all other applications, the choice between thermal spray and paint should be based on life-cycle cost.

4-2. Cost

a. Whenever possible, coating selection should be based on life-cycle cost. In reality, the engineer must balance competing needs and may not always be able to specify the least expensive coating on a life-cycle cost basis. Because of their somewhat higher first cost, thermal spray coatings are often overlooked. To calculate life-cycle costs, the installed cost of the coating system and its expected service life must be known. Life- cycle costs for coating systems are readily compared by calculating the average equivalent annual cost (AEAC) for each system under consideration.

b. The basic installed cost of a thermal spray coating system is calculated by adding the costs for surface preparation, materials, consumables, and thermal spray application. The cost of surface preparation is well known. The cost of time, materials, and consumables may be calculated using the following stepwise procedure:

(1) Calculate the surface area (SA). (SA = length × width)

(2) Calculate the volume (V) of coating material needed to coat the area. ($V = SA \times$ coating thickness)

(3) Calculate the weight of the material to be deposited (Wd). The density (D) of the applied coating is less than that of the feedstock material. A good assumption is that the applied coating is about 90 percent of the density of the feedstock material. The densities of aluminum, zinc, and 85-15 zinc-aluminum wire are 2.61 g/cm^3 (0.092 lb/in.^{3}), 7.32 g/cm^3 (0.258 lb/in.^{3}), and 5.87 g/cm^3 (0.207 lb/in.^{3}), respectively. ($Wd = V \times 0.9\ D$)

(4) Calculate the weight (W) of material used. Estimates of deposition efficiency (DE) for various materials and thermal spray processes are given in Chapter 7, Table 7-2. ($W = Wd/DE$)

(5) Calculate the spray time (T). Spray rates (SR) for various materials and thermal spray processes are given in Chapter 7, Table 7-4. (T = W/SR)

(6) Calculate electricity or oxygen and fuel gas consumption (C). Typical consumption rates (CR) for electricity, fuel gas, and oxygen are available from equipment manufacturers. ($C = CR \times T$)

(7) Calculate cost of materials (CM). ($CM = W \times$ cost per unit weight)

(8) Calculate cost of application (*CA*). ($CA = T \times$ unit labor cost)

(9) Calculate cost of consumables (*CC*). ($CC = T \times$ unit cost of consumable)

(10) Calculate total cost (*TC*) of thermal spray coating. ($TC = CM + CA + CC$)

c. Other factors that increase the cost of thermal spray and other coating jobs include the costs of containment, inspection, rigging, mobilization, waste storage, and worker health and safety.

d. The Federal Highway Administration (FHWA) (1997) compared the performance of a number of coating systems, including paints and thermal spray. Coating life expectancies were estimated based on performance in an aggressive marine atmospheric exposure and a mildly corrosive environment. Installed and life-cycle costs were calculated for each coating system for each exposure. Average equivalent annual costs were calculated based on a 60-year structure life. For the more severe marine atmospheric exposure, thermal spray coatings of aluminum, zinc, and 85-15 zinc-aluminum alloy were the most cost-effective coatings. For the less severe mildly corrosive atmospheric exposure, thermal spray was no more or less cost effective than other coating options.

4-3. Service Life

There are many documented examples of thermal spray coatings of zinc and aluminum with very long service lives. Service life depends on thermal spray coating thickness and the exposure environment. There does not appear to be a significant difference in the long-term performance of thermal spray coatings applied by different processes, including arc, wire flame, and powder flame spray. Thermal spray zinc coatings applied at thicknesses of 250 μm (0.10 in.) have performed for more than 40 years in atmospheric exposures. Zinc thermal spray coatings in potable water tanks have lasted longer than 30 years. The FHWA (1997) report estimates a service life of 30 and 60 years for 85-15 zinc-aluminum alloy coating (150 μm (0.006 in.)) in severe marine and mildly corrosive atmospheres, respectively. USACE has experience with 85-15 zinc-aluminum alloy coatings (400 μm (0.016 in.)) providing 10 years of service in very turbulent ice- and debris-laden water. Table 4-1 provides typical service lives of paint coatings and predicted service life of thermal spray coatings for selected USACE applications. The tabulated service lives are given as the time to first maintenance.

Table 4-1
Predicted Service Life for Selected Thermal Spray Applications

Application	Paint System[a]	Typical Paint Service Life	Thermal Spray System Number[b]	Predicted Thermal Spray Service Life, years
Penstocks	Coal tar epoxy	20 – 30	6-Z-A	30 – 40
Tainter gates	Vinyl zinc-rich	20 – 25	6-Z-A	25 – 35
Tainter and roller gates (interior)	Vinyl	25 – 40	6-Z-A	40 – 50
Tainter gates (very turbulent ice- and debris-laden water)	Vinyl zinc-rich	1 – 2	6-Z-A	8 – 12
Roller gates	Vinyl zinc-rich	25 – 30	6-Z-A	30 – 40
Service bridges	Alkyd/phenolic	10 – 15	5-Z-A or 2-Z	50 - 60
Sector gates (seawater)	Epoxy zinc-rich/coal tar epoxy	15 – 20	8-A	20 - 40

[a] Paint systems described in CEGS-09965:
Coal tar epoxy = Paint System No. 6
Vinyl zinc-rich = Paint System Nos. 3-A-Z, 5-C-Z, and 5-E-Z
Vinyl = Paint System No. 4
Alkyd/phenolic = Paint System No. 2
Epoxy zinc rich/coal tar epoxy = Paint System No. 6-A-Z

[b] 6-Z-A = 400 μm (0.016 in.) 85-15 zinc-aluminum alloy
5-Z-A = 300 μm (0.012 in.) 85-15 zinc-aluminum alloy
2-Z = 300 μm (0.012 in.) zinc
8-A = 250 μm (0.010 in.) aluminum